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Silvical Characteristics of Yellow Birch

(Betula alleghaniensis)

by Adrian M. Gilbert

STATION PAPER NO. 134 • NORTHEASTERN FOREST EXPERIMENT STATION • 1960
FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE • UPPER DARBY, PA.
RALPH W. MARQUIS, DIRECTOR

Preface

MUCH of the silvical information on our forest trees is widely scattered and sometimes difficult to find. To make this material more readily available, the Forest Service is assembling information on the silvical characteristics of all the important native forest tree species of the United States. It is expected that this information will be published as a comprehensive silvics manual.

This report presents the silvical characteristics of one species. It contains the essential information that will appear in the general manual but has been written with particular reference to the species in the Northeast. Similar reports on other species are being prepared by this Experiment Station, and by several of the other regional forest experiment stations.

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About the Author ...

ADRIAN M. GILBERT *received his Bachelor's degree in forestry at the University of Michigan in 1943. Joining the Northeastern Forest Experiment Station in 1946, he served in the Forest Survey of the Northeast. In 1948 he took a year's advanced study at the Swiss Federal Institute of Technology at Zurich, Switzerland. More recently (1957-58) he has been studying for a doctorate at the State University of New York College of Forestry at Syracuse. Since 1952 he has conducted research in the silviculture and management of northern hardwood forests. At present he is in charge of the Northeastern Station's research center at Burlington, Vermont.*

The Elite Birch

OF THE BIRCHES in the Northeast, the yellow birch is the elite species, by far the most valuable as a timber tree. More than that, it is one of the largest deciduous trees of northeastern America. It may reach 100 feet in height and more than 3 feet in diameter, and may live to 300 years of age. Pioneers told tales of the gigantic yellow birches they saw.

The yellow birch *(Betula alleghaniensis)* takes its name from the character of its bark. The bark of young trees is lustrous silvery gray or yellowish, and it peels back into papery thin yellow curls.

Yellow birch is a tree of the cool north and the higher elevations. From Newfoundland and the St. Lawrence country it ranges westward through southern Quebec and Ontario to the north shore of Lake Superior and as far west as Lake of the Woods in Minnesota (fig. 1). It is found throughout the Great Lakes region, growing southward into Iowa, Ohio, and Pennsylvania. Some is found in northern Delaware, and southward along the higher elevations of the Appalachian Mountains as far as Georgia *(22)*.

The largest concentrations of yellow birch timber are found in eastern Canada, northern New York and New England, and the Upper Peninsula of Michigan.

In terms of standing timber, yellow birch is one of the most important hardwoods of the Northeast. U.S. Forest Service forest-survey data show that in total volume it ranks first among all the hardwoods in New Hampshire, second in Maine and Vermont, and third in New York.

Habitat Conditions

CLIMATIC

In the areas where yellow birch grows, precipitation averages about 45 inches a year in the East, 30 inches in the Lake States. About half of this precipitation occurs during the growing season. In the northern areas where the large concentrations of yellow birch timber are found, snowfall averages 80 to 100 inches a year.

The average annual temperature in the botanical range of the species is about 45°F. The July average is about 70°, the January average about 20°. However the temperature extremes range from 100° to -40° *(28)*. The growing season varies from 80 to 140 days; the average is about 120 days.

SOILS

Yellow birch is found growing on soils of the podzol, brown podzolic, and gray-brown podzolic soil groups *(30)*. In glaciated parts of its botanical range the soils are mostly derived from granites, schists, or calcareous rocks; elsewhere in the range the soils are derived from sandstones or shales.

Yellow birch grows on well-drained, moderately well-drained, and poorly-drained loams and sandy loams. On poorly-drained areas the trees are usually found on slight elevations above the ground line, for example, on rotted stumps and windthrow hummocks.

The best growth of yellow birch is found on moderately well-drained sandy loams within the podzol and brown podzolic soils groups.

PHYSIOGRAPHIC

Yellow birch thrives best on flats and lower slopes. In hilly mountainous terrain it does better on the cooler northern and eastern slopes. In New York and New England yellow birch grows at elevations up to 2,500 feet; in the Lake States it grows up to about the 1,600-foot elevation. In the southern Appalachians it is almost always found above 3,000 feet.

BIOTIC

Although yellow birch may be present in practically all stages of the forest succession, it is found mostly in

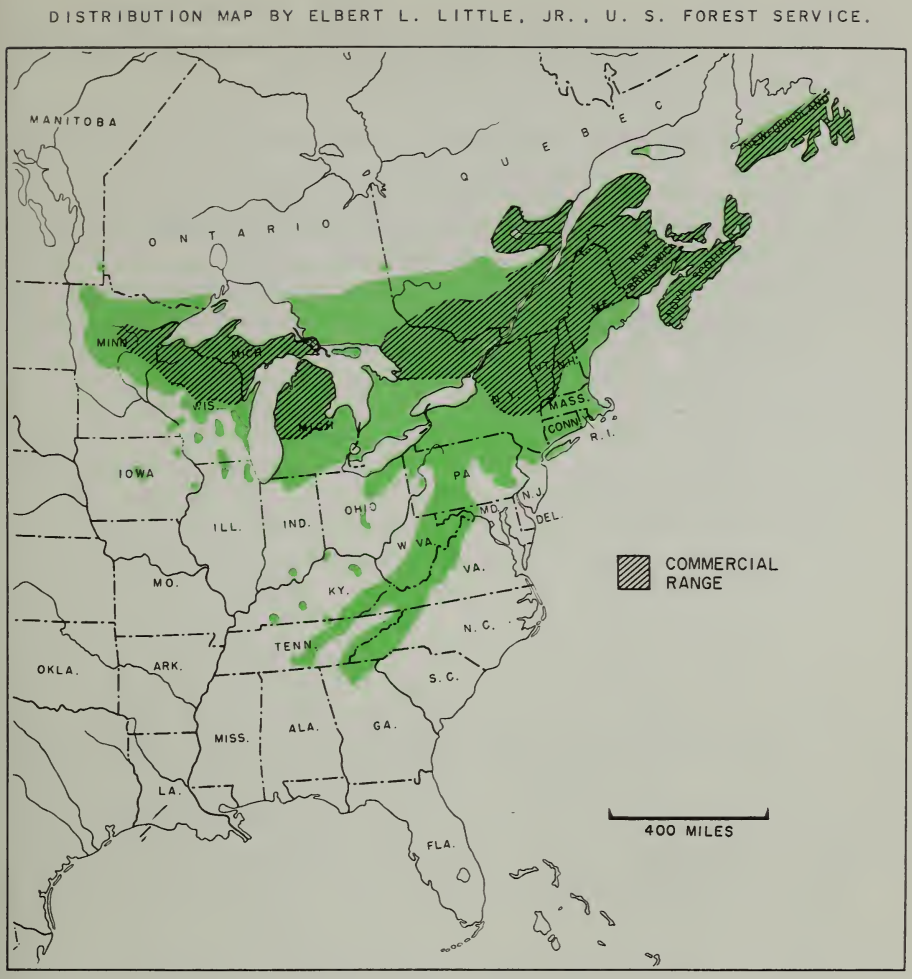

Figure 1.--*The natural range of yellow birch. Shaded areas show the commercial range, where heaviest concentrations of yellow birch timber are found.*

climax associations; that is, a rather permanent, self-perpetuating kind of forest as against the less lasting kind that comes in, say, after fire. It is found in 21 of the cover types defined by the Society of American Foresters *(25)*. The most important of these are:

Type 23 -- Hemlock
Type 24 -- Hemlock-yellow birch
Type 25 -- Sugar maple-beech-yellow birch
Type 30 -- Red spruce-yellow birch
Type 32 -- Red spruce

Yellow birch is also found associating with the paper birch and gray birch-red maple cover types, which are pioneer types that often fill in on abandoned land.

Among the more common tree associates of yellow birch are:

American beech	*Fagus grandifolia*
Balsam fir	*Abies balsamea*
Basswood	*Tilia americana*
Bigtooth aspen	*Populus grandidentata*
Black cherry	*Prunus serotina*
Eastern hemlock	*Tsuga canadensis*
Gray birch	*Betula populifolia*
Paper birch	*Betula papyrifera*
Pin cherry	*Prunus pensylvanica*
Quaking aspen	*Populus tremuloides*
Red maple	*Acer rubrum*
Sugar maple	*Acer saccharum*
Red spruce	*Picea rubens*
Sweet birch	*Betula lenta*
White ash	*Fraxinus americana*
White pine	*Pinus strobus*

The shrubs that are commonly found in association with yellow birch include the following:

Striped maple	*Acer pennsylvanicum*
Mountain maple	*Acer spicatum*
Alternate leaf dogwood	*Cornus alternifolia*
Beaked hazelnut	*Corylus cornuta*
Leatherwood	*Dirca palustris*
American fly honeysuckle	*Lonicera canadensis*
Ground hemlock	*Taxus canadensis*
Witch hobble	*Viburnum alnifolium*

Of these, the two maples, the honeysuckle, and the witch hobble are the most common in the Northeast. Ground hemlock once was common, and still is in parts of New England and Canada; but where excessive deer populations have built up--as in the Allegheny Plateau and over much of the Lake States region--this shrub may be virtually eliminated.

Life History

FLOWERING & FRUITING

As with all species in the genus Betula, yellow birch is monoecious; that is, male and female flowers occur on the same tree but in separate catkins. Although bi-sexual catkins have been found on some birches, none have been reported for yellow birch.[1] However, the flowering characteristics of yellow birch have not been studied intensively.

The staminate catkins form in late summer or fall. They elongate and become quite conspicuous the following spring *(29)*. The pistillate flowers appear during the first three weeks in May, about the same time the trees begin to leaf. They are terminal on short branchlets. The fruit, a winged nutlet located in the scales of the strobiles, ripens in late July or August (fig. 2).

SEED PRODUCTION

Seed production of yellow birch begins at about 40 years, when trees in the main crown canopy may average about 5 inches in diameter at breast height. The best seed production occurs after 70 years, at which time the trees may be 8 or 9 inches in diameter. Good seed crops are reported to occur every 1 or 2 years *(29)*. The germinative capacity averages 27 percent, with a range from 6 to 48 percent.

Heavy seed fall begins with cold weather in October *(2)*. Millions of seeds may be discharged per acre. They are dispersed by wind. When a hard snow cover is present, seed may be blown along the surface or picked up in wind currents and moved hundreds of feet from their source. Eventually, many of such migrant seeds may collect in small pockets in the snow and subsequently settle to the ground at these spots when the snow melts.

Indications are that the seeds of highest germination capacity are those that fall first when the catkins begin to dry *(14)*.

The seeds have internal dormancy and, if not autumn-sown, should be stratified in moist sand or peat at 40° F. for at least one month before sowing *(14, 29)*.

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[1]Personal communication from Dr. F. U. Klaehn, assistant professor of silviculture, State University of New York College of Forestry, Syracuse, N. Y.

PHENOLOGY

Phenological observations (average dates) recorded at Bartlett, N. H., Kane, Pa., and Dukes, Mich., are tabulated below:

	Bartlett	*Kane*	*Dukes*
Leaf bud swell	April 16	May 8	May 6
Begins to leaf	May 5	May 12	May 19
Full leaf	--	May 21	June 11
Flowering	May 1	May 21	May 12
Seed ripening	--	July 30	Aug. 20
Seed fall begins	Oct. 5	Aug. 10	Sept. 18
Seed fall ends	Feb.	Aug. 17	--
Leaf fall begins	Sept. 20	Oct. 8	Sept. 24
Leaf fall ends	Oct. 15	Oct. 23	Oct. 17
Start of height growth	--	--	May 16
End of height growth	--	--	Aug. 10

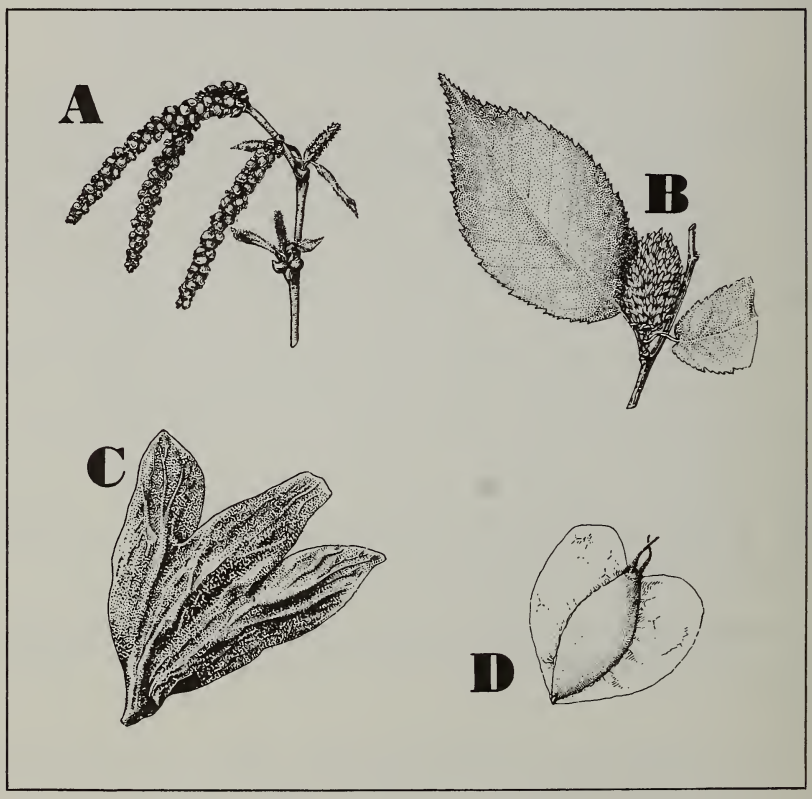

Figure 2.--*The flowers and seed of yellow birch.* A, *flowers, staminate catkins pendant.* B, *strobile (cone).* C, *bract, or strobile scale.* D, *fruit, a winged nutlet.*

Figure 3.--*Yellow birch seedlings tend to develop a shallow, spreading root system rather than a taproot.*

VEGETATIVE PROPAGATION

Yellow birch will sprout from stumps, especially from younger trees. Seedling sprouts apparently develop as well as seedlings. Since neither foresters nor horticulturists have had much reason to propagate the species by cuttings or by grafting, little is known of its adaptability to these methods.

SEEDLING DEVELOPMENT

Normally, germination takes place in the spring following seed dispersal *(20)*. But according to one report, seed that had lain over until the second year produced vigorous seedlings *(2)*.

Yellow birch regenerates very poorly in the relatively thick litter of an undisturbed forest *(5)*. Though large numbers of seeds may germinate, their roots are too weak to pierce the litter (fig. 3). Drying of the litter during the growing season is usually lethal to the puny seedlings. If

partially protected from sun and wind, either humus soils or straight mineral soil are good seedbeds. Excellent seedbed conditions are created by such disturbances as logging, fire, and windthrow. In a managed forest, the area of favorable seedbed and the amount of yellow birch regeneration can be increased by mechanical scarification of the site after logging *(12, 13)*.

Without some disturbance of the forest floor, yellow birch regeneration is restricted mostly to cracks in boulders and to rotted logs and stumps. A study in Pennsylvania showed that 38 percent of the yellow birch grew on such rotted wood *(11)*. These regeneration habits of yellow birch explain the frequent stilt-rooting of the species.

In Quebec, with artificial seedings under forest conditions, first-year germination was highest under partial shade, almost as high under full canopy, but much lower in the open *(16)*. On the other hand, seedling survival on mineral soil after 2 years, in percent of total germination, was highest in the open and next under partial shade.

Successful survival depends upon a particular combination of temperature, moisture, and light. The seedlings need overhead light, but a cool, moist seedbed.

Nursery-grown seedlings in the Lake States, grown at about 15 per square foot after 1 year, averaged 3.6 inches in height and 6.1 inches in root depth; and after 3 years, 20.5 inches in height and 12.6 inches in root depth *(26)*.

After harvest cuttings, regeneration of yellow birch is most successful in small openings (patches) of 0.1- to 0.5-acre in size. In the Lake States, 0.1-acre openings are considered best *(6)*. In the Northeast, where annual precipitation is higher, the openings may be larger. As the openings increase in size, yellow birch seedlings tend to become more plentiful along the edges than in the center.

The superiority of patch cuttings in northern hardwoods for regenerating yellow birch, as compared to other cutting methods, is shown below by data taken in a New Hampshire study 10 to 15 years after the cuttings were made *(15)*.

Method of cutting	*Milacres stocked with yellow birch (percent)*
1/3-acre patches	21
Clear-cut	12
Tree selection	5

Stocked milacres were those on which the sapling of greatest apparent potential for a future crop tree was a yellow birch. Most of the other quadrats, of course, were stocked with other species.

SAPLING STAGE TO MATURITY

Growth

Given overhead light, young yellow birch makes moderately rapid height growth. In clear-cut openings less than 1 acre in area, made in a mature stand of the birch-beech-maple type on an average site in the White Mountains of New Hampshire, the order of relative heights of 6-year-old saplings, beginning with the tallest species, was as follows: pin cherry, bigtooth aspen, paper birch, white ash, yellow birch, sugar maple, American beech.

The yellow birch were 8 to 10 feet tall at 6 years. At 23 years the positions were about the same, except that most of the pin cherry had disappeared. Yellow birch then averaged about 30 feet.

In the Adirondack Mountains of New York, yellow birch saplings in a northern hardwood stand that followed a burn averaged 6 feet at 6 years, 12 feet at 10 years, and 22 feet at 14 years *(18)*.

In the same region, stem analyses were made of an almost pure 60-year stand of yellow birch that had followed a charcoal cutting *(18)*.

Age (years)	*Total height (feet)*	*D.b.h. (inches)*
10	13.8	1.3
20	28.1	2.9
30	38.4	4.3
40	44.6	5.1
50	49.7	5.9
60	53.6	6.5

The average annual diameter increment of yellow birch poletimber and sawtimber is small in relation to its sapling height growth. On average sites, the annual increment is about 0.1 inch *(9)*; on poor sites, about 0.05 inch.

Crown lengths and widths of yellow birch generally are a little less than those of sugar maple and beech *(8)*. Crown lengths are normally about 40 percent of total height.

Figure 4.--*A mature yellow birch in a beech-birch-maple forest in New England. One of the largest deciduous trees, yellow birch may grow 100 feet tall and 3 feet in diameter.*

Crown widths for several diameter classes, as measured in the Lake States, are as follows:

Diameter class (inches)	*Average crown width (feet)*
6	12
12	20
18	27
24	34

Mature yellow birch on average sites may be 90 to 100 feet tall and more than 30 inches in diameter at 200 years. In northern New England, such trees have a form class of about 80 and a clear length of 40 to 46 feet (fig. 4).

Tolerance

The species is the most tolerant of the birches native to eastern North America; it needs less direct overhead light than the other birches and is found in smaller openings. Still, in comparison with other trees of all kinds, yellow birch generally is rated as intermediate in tolerance. And although it is well represented in many climax types of northern forests, it tends to give way with age to more tolerant species, especially on the less moist sites.

Pruning

In dense stands yellow birch prunes itself fairly well. Yet when such trees are exposed by careless cutting or mortality in the stand, they commonly develop a profusion of epicormic branches from dormant buds *(16)*, thus nullifying the effects of earlier self-pruning.

Favorable results have been reported in a study of artificial pruning on 20-year-old yellow birch in Michigan. The pruned trees were in a northern hardwood stand of about 1,400 trees per acre; no thinning or other cutting was done on the study area. Eleven years after pruning to 18 feet--about half of total tree height--examination of the stand showed that neither height nor diameter growth had been reduced. Boles cleared by pruning had remained clear. A few epicormic branches had appeared after the pruning, but all died within 3 years. Wounds from flush pruning up to 2 inches in diameter healed over in 6 to 8 years without decay or other defect; in larger wounds there was some associated defect but no infection of heart rot *(24)*.

Weaknesses

The thin bark of young yellow birch (fig. 5) is highly inflammable *(10)*, although normally the forest types containing yellow birch are not very susceptible to fire. But should it occur, yellow birch is easily injured. Butt rot may follow fire damage.

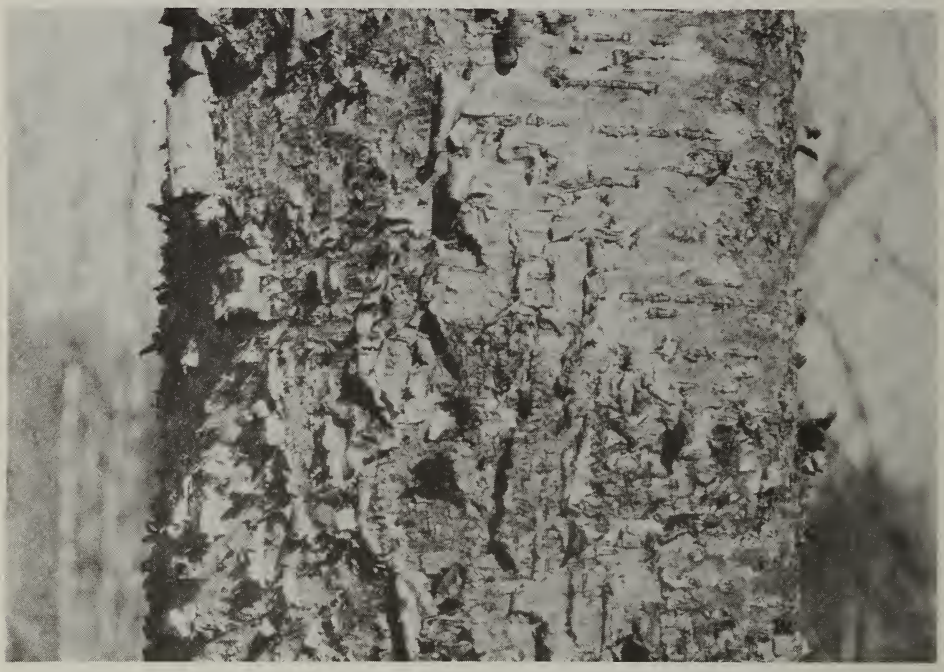

Figure 5.--*The bark of yellow birch, a distinguishing characteristic. On young trees the bark is lustrous silvery gray or yellowish, peeling back into papery thin yellow curls.*

Yellow birch trees usually develop a shallow, widespreading root system; this subjects them to windthrow. Trees that have become established on boulders and those that are stilt-rooted after having started on logs or stumps are especially vulnerable to toppling by wind (fig. 6 and 7).

Insects & Diseases

When stands are opened up excessively by cutting, the change in environment may cause a decline in yellow birch that is commonly referred to as post-logging decadence. Birch in undisturbed stands, however, may undergo a similar

Figure 6.--*This yellow birch, which apparently began life as a seedling taking root in the crack of a boulder, has accommodated itself to the boulder by sending roots down around it.*

Figure 7.--*Stilt rooting. This tree probably began as a seedling growing atop a stump, which rotted away and left the tree standing on stilt roots.*

decline; here the malady is called birch dieback. This condition is prevalent in the Maritime Provinces of Canada and in northern New England. No causative pathogen has been found. Theories have been advanced that the dieback, like post-logging decadence, is a reaction to changed environment --specifically, to the gradual warming of the climate that has been occurring over the past several decades.

The symptoms of post-logging decadence and dieback are very similar. At first, the leaves curl and turn yellowish. Then the twigs die back from the tips. Eventually all or a considerable part of the crown dies *(20)*. In some cases there may be prolific epicormic branching along the stem. Some trees die while others recover by growing a new crown, but rot may enter the stem from the dead limbs.

Very little is known about what triggers birch dieback. According to a study in New Brunswick, Canada *(21)*, the root system of yellow birch is extremely sensitive to high soil temperatures. An increase of summer soil temperature of 3.6° F. increased rootlet mortality tenfold, from 6 to 60 percent. However, at Chalk River, Ontario, a 10° increase in soil temperature from one year to the next was accompanied by no noticeable change in the health of the trees *(7)*. Discrepancies in results may be due to the relatively brief duration of the studies, differences in site, or in methodology.

A recent study of yellow birch dieback in relation to growth patterns and climate, coupled with a careful examination of the history of the disease, casts considerable doubt on theories that dieback is some sort of purely physiological disturbance. It is shown that the malady has spread in the manner of an infectious disease from the locality of its first recognized appearance in central New Brunswick in 1932. It was found that the growth behavior of unaffected trees during drought differs from that of trees afflicted with dieback: during drought, high-vigor trees suffer less growth reduction than low-vigor ones, whereas during early years of dieback the more vigorous trees suffer the greater growth reduction. It is pointed out that a greater show of symptoms in plants of high vigor is characteristic of virus infections. The sum of the evidence adduced in this study supports a hypothesis that birch dieback is an infectious disease caused by a virus *(3)*.

Birches are subject to infestation by the bronze birch borer, *Agrilus anxius*. Apparently the insects rarely complete the cycle from egg to adult on normal, healthy trees. However, on dying trees or those showing the symptoms

of birch dieback, they can complete the cycle. The tunnelings of the borer weaken the tree and may cause death.

Yellow birch is an occasional host to two leaf feeders: the birch skeletonizer, *Bucculatrix canadensisella*; and the gypsy moth, *Porthetria dispar*. The birch leaf-mining sawfly, *Phyllotoma nemorada*, can strip entire trees, but it is rarely fatal *(4)*.

Yellow birch is often infected with heart rots. The false tinder fungus, *Fomes ignarius*, is very common on birch. *Fomes fomentarius*, the tinder fungus, is most common on dead birch, but occasionally attacks living trees *(23)*. Less common on yellow birch is *Fomes applanatus*.

The stem canker, *Nectria galligena*, is common on yellow birch *(1)*. It reduces the quality of the main stem, increases the chances of wind breakage, and provides a footing for other diseases.

Two species of Poria are found on yellow birch: *Poria laevigata* and *Poria obliqua (27)*. *P. laevigata* has characteristic bark-covered cankers on mature birch; *P. obliqua* is common on the face of old Nectria cankers, and its sterile conks are found on branch stubs or trunk wounds. Both indicate extensive decay.

Yellow birch may be girdled by mice, rabbits, and porcupines. It is a favorite browse of deer. Grouse feed on its buds, catkins, and seed; songbirds eat the seeds, too.

In general, yellow birch may be described as a very sensitive tree. It is attacked heavily by insects and diseases. It adapts very poorly to changes in environment. Although yellow birch seeds often and prolifically, it is difficult to bring it through the seedling stage and on to maturity.

Special Features

Yellow birch ranks high among the hardwoods used in furniture manufacture in the United States *(19)*. In the qualities that suit it well for furniture, it is similar to hard maple and black cherry.

The wood of yellow birch is heavy, hard, strong, and dense. The heartwood is light brown in color, tinged with

red; the sapwood is nearly white. The wood machines well and takes finish beautifully.

Yellow birch is also used for flooring and lumber. Large logs are sought by veneer makers, for manufacture into fine plywood and such items as modern flush doors.

Wintergreen oil is present in the inner bark of the stem and roots, but in much smaller quantities than in sweet birch.

Races and Hybrids

No racial tests of yellow birch have been reported. One natural hybrid has been found, *Betula xpurpusii*, a cross between yellow birch and *Betula pumila* var. *glandulifera*, a shrub. It occurs in the Lake States *(17)*.

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These Silvical Papers...

This is one of a series of 15 silvical papers to be published by the Northeastern Forest Experiment Station. The series will include papers on the following species:

*Green ash
*White ash
Beech
Paper birch
*Sweet birch
*Yellow birch
Black cherry
Red maple
*Balsam fir
*Red spruce
*Eastern hemlock
Eastern white pine
*Pitch pine
*Virginia pine
*Atlantic white-cedar

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*Already published.


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